Federal Land Assistance, Management and Enhancement (FLAME) Act Suppression Expenditures for Interior and Agriculture Agencies:

September 2015 Forecasts for Fiscal Year 2016

Supporting Documentation

Report Date: August 15, 2015

Executive Summary

The U.S. Department of Agriculture (USDA) Forest Service is forecast to spend, with 90 percent confidence, between $522 million and $1.486 billion in Fiscal Year (FY) 2016, with a median forecast of $1.004 billion. The FY 2016 Forest Service median forecast is in the middle tercile of expenditures since 1985.

The U.S. Department of the Interior (DOI) is forecast to spend, with 90 percent confidence, between $250 million and $505 million, with a median forecast of $378 million. DOI expenditures are forecasted to be in the middle tercile of expenditures since 1985.

Overview

With the passage of the FLAME Act in 2009, both the Forest Service and the Department of the Interior are required to produce forecasts of annual suppression expenditures three times during each fiscal year: March, May, and July, with a September outlook for the next fiscal year required when the next fiscal year budget is not approved by Congress and the President by that date. Scientists at the USDA Forest Service Southern Research Station provide these forecasts to both the Forest Service and the DOI.

Forecast

USDA Forest Service

The median forecast is $1.004 billion and the 80, 90 and 95 percent confidence bands around the median forecast are provided in Table 1. The forecast probability density is shown in Figure 1 and the not-to-exceed levels at a range of probabilities are reported in Table 2.

We used the mean percent spent in each region to forecast the tercile of expenditures in each region (Table 3). When compared to expenditures since 1995, Regions 2, 3, 8, 9, and 10 are forecast to be in the upper tercile in 2016, while the remaining regions, the Rest of Forest Service, and the Forest Service in total are forecast to have expenditures in the middle tercile.

Table 4 provides the minimum, mean, median, and maximum regional percentages from 1995 to 2014, as well as the 2016 dollar amount for the average percent for each region based on the

median forecast for the total Forest Service. The 90% upper confidence level is also provided based on simulations from applying the mean percentage by region to the total Forest Service forecast.

Department of the Interior

Table 5 shows the median FY 2016 suppression expenditure forecast for DOI ($378 million in 2016 dollars), as well as the 80, 90, and 95 percent confidence band. As in the Forest Service forecast, uncertainty surrounding the DOI forecast for FY 2016 is illustrated with a the probability density graphic (Figure 2) developed with 50,000 Monte Carlo random forecasts. As Table 6 shows, this model states that there is a 1 percent chance that the Department of the Interior suppression expenditures will fall below $198 million. In contrast, there is a 99 percent chance that these expenditures will fall below $558 million. The median forecast expenditure from the Monte Carlo simulation for the Department is in the middle tercile of expenditures in real dollar terms compared to the observed expenditures since 1985.

Modeling

Modeling Framework for the September 2015 Forecast of FY 2016 Forest Service Expenditures

To meet the statutory requirements of the FLAME Act, the Forest Service developed statistical models based on peer reviewed research[1,2]. These models have been developed for several forecast horizons and the September FLAME forecast is the most challenging because climate and drought information are not available to forecast expenditures for the next fiscal year. Additionally, total FY 2015 data on suppression expenditures in total and by region will not be available until after the end of the FY. Therefore, this year the total departmental forecasts provided are similar to the outyear forecasts made available for long-term budgeting (2 to 10 years out).

This report is the first FLAME forecast issued for FY 2016, and it includes some changes compared to the reports issued in previous years. The approach used here forecasts total Forest Service suppression expenditures using a time series model over data from 1985 to 2014[3]. The statistical model relates expenditures in the coming fiscal year to lagged suppression expenditures (three years) and a year 2000 shift. Then, regional shares are calculated based on the average share over the data available (1995 to 2014) and the historical range is provided to show how much the shares have actually varied over the time frame. Additionally, the percentage estimates are simulated to provide confidence intervals around the median forecast similar to the simulations performed on the total Forest Service model. This is different from last September's forecast that only provided the average percentage by region. The expenditures

[1] Prestemon, J.P., K.L. Abt, and K. Gebert. 2008. Suppression cost forecasts in advance of wildfire seasons. Forest Science 54(4):381-396.
[2] Abt, K.L., J.P. Prestemon, and K. Gebert. 2009. Wildfire suppression cost forecasts for the US Forest Service. Journal of Forestry 107(4):173-178.
[3] The suppression expenditure data used to calculate the 10-year moving average.

made by the National Interagency Fire Center, Washington Office, and research stations are classified as the rest of the Forest Service, "RFS."

Equation estimates are shown in Table 7. The model R^2 is 0.65 indicating 65% of the variation in suppression expenditures is explained by the variables included in the model. Durbin's h statistic, designed to detect serial autocorrelation in the residuals of autoregressive equations (those that include lagged values of the dependent variable), was insignificant (p-value=0.37).

Data for modeling were annual FY totals of suppression expenditures from 1988 to 2014 (except the three year lagged suppression expenditure series uses data back to 1985). To erase the effects of general price inflation, all expenditures were deflated to the value of a dollar in 2014 using the gross domestic product deflator from the President's budget[4]—that is, models were estimated and expenditures were forecast in "real" dollar terms. Forecasted values were then converted to expected FY 2016 dollars.

When generating a forecast distribution (see Figure 1), we randomly sampled from the equation error distribution to account for uncertainty in the forecast. This Monte Carlo forecast, which is repeated 50,000 times, does not produce a single forecast of fiscal year expenditures. Rather, it generates a distribution of expenditure predictions. This distribution is summarized in many ways: a forecast density distribution (Figure 1), a table reporting a median forecast and the lower and upper bounds of likely expenditures (Table 1), and a table of not-to-exceed expenditures by probability levels (Table 2). We also provide each region's forecasted expenditures based on the mean share evaluated at the median forecast value and describe where each region's median expenditure forecast falls within the observed historical expenditures, in real dollar terms (Table 4). Regional shares are calculated using data from 1995 to 2014, the years when consistent regional level expenditure data are available. Descriptive statistics for each region's share are provided to give an idea of the actual variability in shares over the time frame.

Model fitness is reported in Figure 3 and Table 8. The graph shows how well the September 2015 FLAME Act Forecast Model of FY 2016 forecasts out-of-sample using the leave-one-out cross validation method (produced by dropping the observation of the forecast year, and doing this iteratively over the historical data), compared with observed expenditures for the Forest Service. Table 8 shows that the root mean squared error of the model used in this September 2015 forecast of FY 2016 expenditures, when applied to the 1988-2014 period, was $287 million and that it had a negative bias, tending to under-forecast by about $1.4 million (0.14 percent) (This bias was not used to adjust the September 2015 forecast for FY 2016.)

The forecast for the total Forest Service had a Mean Absolute Percent Error of 28 percent, meaning the typical forecast averaged 28 percent above or below expenditures actually incurred during the 1988-2014 period. Finally, this model correctly predicted the direction of change in year-over-year suppression expenditures by the Forest Service 89 percent of the time. The model predicted that the FY 2016 median forecast expenditures would be lower than the FY 2014 actual expenditures (Figure 3).

[4] Deflator source:
http://www.whitehouse.gov/sites/default/files/omb/budget/fy2015/assets/hist.pdf

Modeling Framework for the September 2015 Forecast of FY 2016 Department of the Interior Expenditures

The forecast model for the Department of the Interior (DOI) is based on departmental total expenditure data—i.e., aggregated across all agencies and geographic regions. The September 2015 FLAME Act Model for FY 2016 covered department-wide expenditures for fiscal years 1988 to 2014 (although DOI expenditure data back to 1985 were needed to produce the three year lag).[5] We modeled aggregate DOI expenditures using a time series model specification involving a three year lag of DOI expenditures and a variable that designates the year 2000 shift in expenditures. This model is structured identically to the Forest Service model and covers the exact same years (1985-2014).

The DOI suppression expenditure forecast equation is reported in Table 9. The estimated equation explained 74 percent of the variation ($R^2 = 0.74$) in annual DOI suppression expenditures over the historical time period, 1988-2014. The Durbin h statistic indicated no evidence (p=0.47) of residual autocorrelation in the model estimation errors.

Model fitness measures of the September FLAME Act Forecast Model for FY 2016 for DOI are reported in Table 10. As in the case of the Forest Service September FLAME Act Forecast Model, the DOI September FLAME Act Forecast Model was evaluated using the cross-validation procedure for the years 1988 to 2014. This September forecast model had a root mean squared error of $76 million. The model had a bias of negative $1.5 million (0.49 percent, but this historical bias was not used to adjust the 2016 forecast).

The model had a Mean Absolute Percent Error of 24 percent. It correctly predicted the direction of change in suppression expenditure for the agency from one year to the next about 78 percent of years. The model predicted that the FY 2016 median forecast expenditures would be higher than the FY 2014 actual expenditures (Figure 4).

[5] Although geographical and agency disaggregated data are available for recent years (since the early 2000's), there are insufficient data for modeling by geographic region or agency within the Department.

Table 1. September 2015 FLAME Act forecasts of FY 2016 suppression expenditures of the USDA Forest Service, by in FY 2016 dollars.

	(Millions of 2016$)
Median Estimate	1,004
80% Confidence Lower Limit	629
80% Confidence Upper Limit	1,379
90% Confidence Lower Limit	522
90% Confidence Upper Limit	1,486
95% Confidence Lower Limit	430
95% Confidence Upper Limit	1,578

Table 2. September 2015 FLAME Act forecasts of FY 2016 suppression expenditures of the USDA Forest Service, probability of falling below specified amount in FY 2016 dollars.

Probability (%) of Falling Below Indicated Dollar Amount	Realized Amount (Millions of 2016$)
1	323
5	522
10	629
20	757
30	850
40	930
50	**1,004**
60	1,078
70	1,158
80	1,251
90	1,379
95	1,486
99	1,686

Table 3. September 2015 FLAME Act forecasts of FY 2016 suppression expenditures of the USDA Forest Service, by tercile.

Region	Tercile of Expenditures Projected, Since 1995
1	Middle
2	Upper
3	Upper
4	Middle
5	Middle
6	Middle
8	Upper
9	Upper
10	Upper
RFS	Middle
Total	Middle

Table 4. Descriptive statistics for regional percentages and the mean regional expenditures based on the median Forest Service forecast (1995-2014).

Region	Minimum %	Mean %	Median %	Maximum %	Median Millions of 2016$	90% Upper Millions of 2016$
1	2	8	6	35	89	259
2	1	3	3	12	33	106
3	4	10	9	28	112	243
4	4	8	6	18	104	211
5	6	29	28	63	337	623
6	7	14	13	24	133	316
8	1	4	3	16	54	106
9	<1	1	1	3	15	34
10	<1	<1	<1	2	3	10
RFS	<1	22	21	54	261	561

Table 5. September 2015 FLAME Act forecasts of FY 2016 suppression expenditures of the Department of the Interior in FY 2016 dollars.

	(Millions of 2016$)
Median Estimate	378
80% Confidence Lower Limit	279
80% Confidence Upper Limit	477
90% Confidence Lower Limit	250
90% Confidence Upper Limit	505
95% Confidence Lower Limit	226
95% Confidence Upper Limit	529

Table 6. September 2015 FLAME Act forecasts of FY 2016 suppression expenditures of the Department of the Interior, probability of falling below specified amount in FY 2016 dollars.

Probability (%) of Falling Below Indicated Dollar Amount	Realized Amount (Millions of 2016$)
1	198
5	250
10	279
20	313
30	337
40	358
50	**378**
60	397
70	418
80	443
90	477
95	505
99	558

Table 7. Ordinary least squares regression equation estimates used in the September 2015 forecast of FY 2016 suppression expenditures of the USDA Forest Service.

Variable	Parameter estimate	Standard error	T value	Significance level
Intercept	867,573,814	108,492,828	8.00	<0.001
Forest Service Costs (t-3)	-0.48	0.14	-3.56	0.0006
If year>1999	764,462,313	114,097,090	6.70	<0.001
R^2	0.65			
Adjusted R^2	0.62			
Durbin h statistic	1.10			
(significance level)	0.37			
Number of obs.	27			

Note: The dependent variable is the annual total real dollar suppression expenditures.

Table 8. Cross-validation of the ordinary least squares regression model used in the September 2015 Forecast of FY 2016 suppression expenditures of the USDA Forest Service calculated over data from 1988-2014 in FY 2016 dollars.

	Millions of 2016 dollars	Percent
Root mean square error	287	-
Bias	-1.4	-
Percent bias	-	-0.14
Mean absolute percent error	-	28
Percent correct direction of change	-	89

Table 9. Equation estimates used in the September 2015 Forecast of FY 2016 suppression expenditures of the Department of the Interior.

Variable	Parameter estimate	Standard error	T value	Significance level
Intercept	273,758,951	32,151,836	8.51	<0.001
DOI Costs (t-3)	-0.44	0.13	-3.27	0.0015
If year>1999	268,210,311	33,830,234	7.93	<0.001
R^2	0.74			
Adjusted R^2	0.71			
Durbin h statistic	0.87			
(significance level)	0.47			
Number of obs.	27			

Note: The dependent variable is the Department's annual real dollar suppression expenditures.

Table 10. Cross-validation of the equation used in the September 2015 Forecast of FY 2016 suppression expenditures of the Department of the Interior calculated over FY 1988-2014.

	Millions of 2016 dollars	Percent
Root mean square error	76	-
Bias	-1.5	-
Percent bias	-	-0.49
Mean absolute percent error	-	24
Percent correct direction of change	-	78

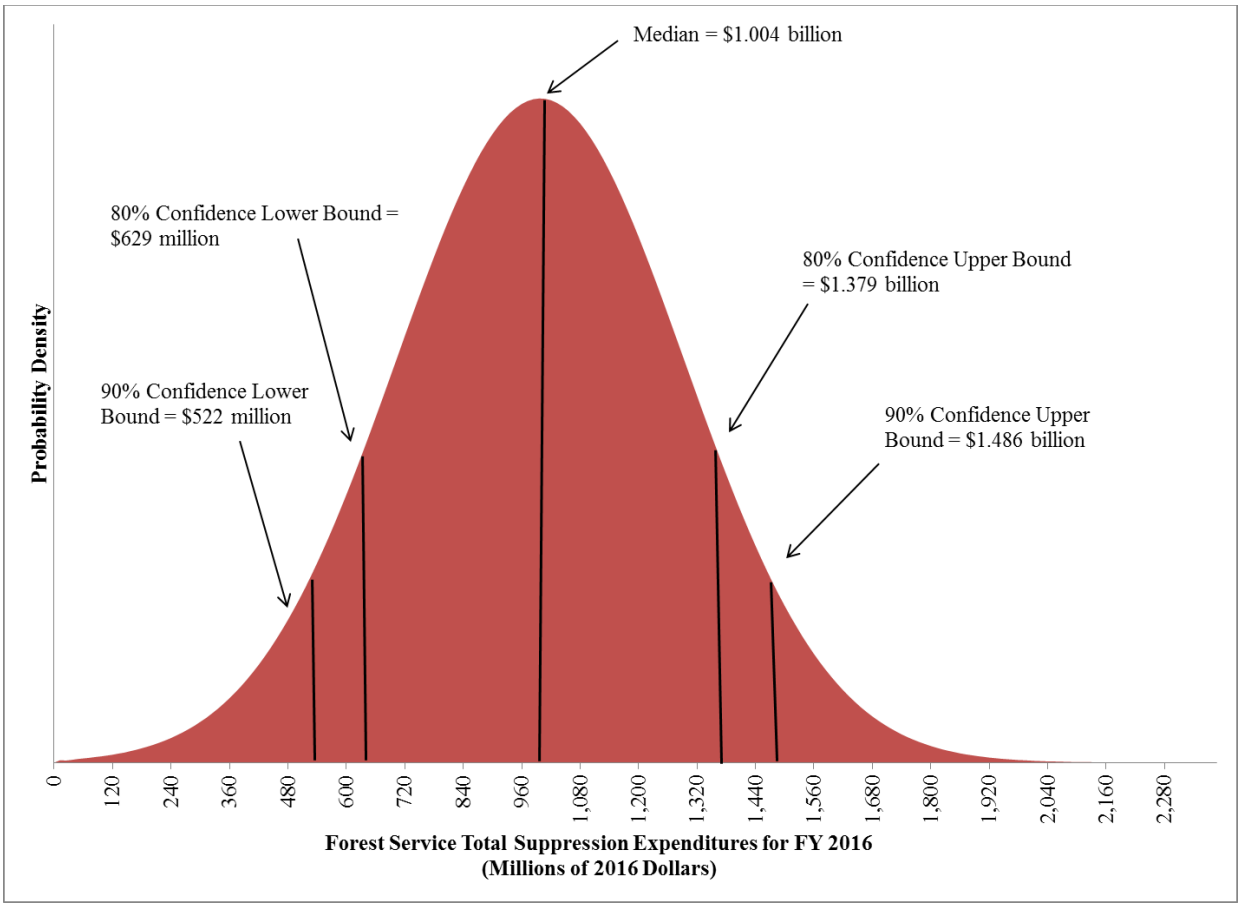

Figure 1. USDA Forest Service suppression expenditure forecast probability density, FY 2016, September 2015 FLAME Act Forecast Model.

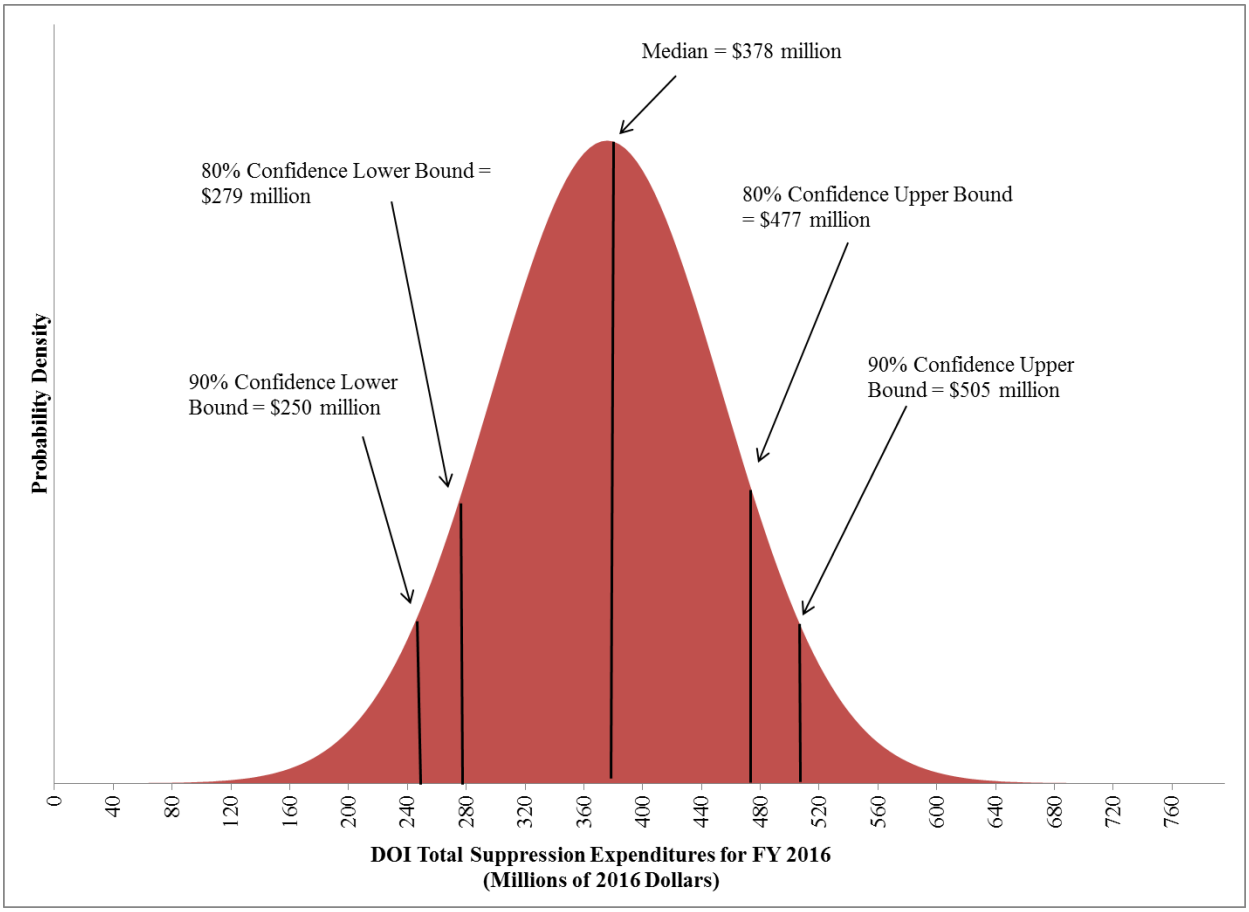

Figure 2. Department of the Interior suppression expenditure forecast probability density, FY 2016, September 2015 FLAME Act Forecast Model.

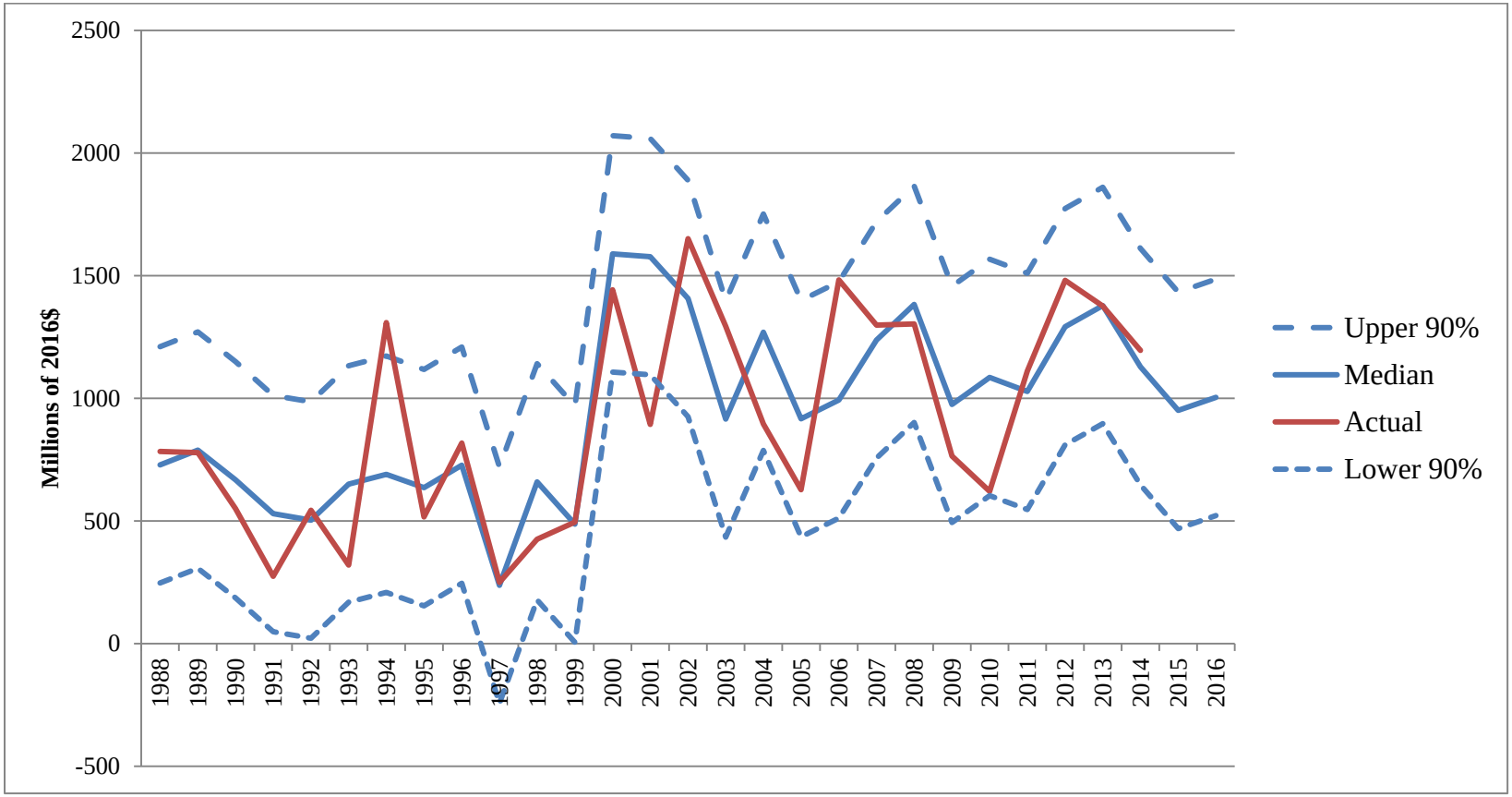

Figure 3. Observed historical USDA Forest Service suppression expenditures (1988-2014) and the forecasts of these expenditures (1988-2016) using the September 2015 FLAME Act forecast model. All forecasts for each FY are the point estimates generated with a cross-validation procedure. (Note: values shown in the figure are in constant 2016 dollars.)

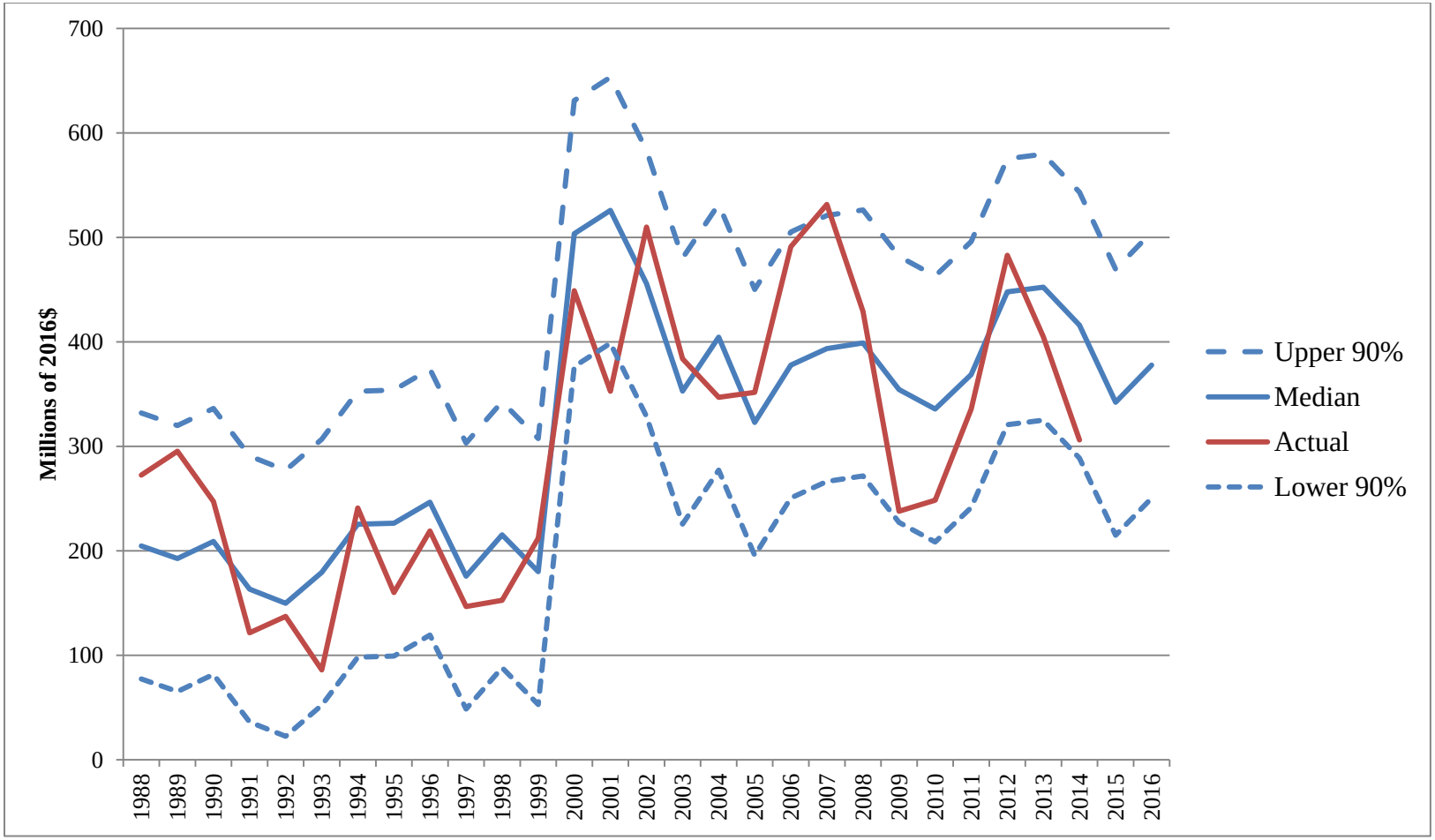

Figure 4. Observed historical Department of the Interior suppression expenditures (1988-2014) and the forecasts of these expenditures (1988-2016), using the September 2015 version of the September FLAME Act Forecast Model. All forecasts for each FY are the point estimates generated with a cross-validation procedure. (Note: values are in constant 2016 dollars)